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On the theory of the proton free induction decay and Hahn echo in polymer systems: The role of intermolecular magnetic dipole-dipole interactions and the modified Anderson-Weiss approximation

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Abstract

The influence of the intermolecular magnetic dipole-dipole interaction on the free induction decay (FID) as well as on the Hahn-echo of proton spins in polymer melts is investigated. It is shown that for isotropic models of polymer dynamics, when polymer segment displacements do not correlate with an initial chain conformation, the influence of the intermolecular magnetic dipole-dipole interactions to the FID and Hahn echo is increasing more rapidly with evolution time than the corresponding influence of the intramolecular magnetic dipole-dipole interactions. On the other hand, the situation is inverted for the tube-reptation model: here the influence of the intramolecular magnetic dipole-dipole interactions to the FID and Hahn echo is increasing faster with time than the contribution from intermolecular interactions. A simple expression for the relative mean squared displacements of polymer segments from different chains is obtained from the intermolecular contribution to the FID. A modified Anderson-Weiss approximation, taking into account flip-flop transitions between different spins, is proposed and on that basis, the conditions for extracting the relative intermolecular mean squared displacements of polymer segments from the intermolecular contribution to the proton FID is established. Systematic investigations of intermolecular contributions, which were considered as an unimportant factor for FID and Hahn echo in polymer systems by most previous works, actually cannot be considered as negligible and opens a new dimension for obtaining information about polymer dynamics in the millisecond regime. © 2012 American Institute of Physics.

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